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Climate knowledge cultures: Stakeholder perspectives on change and adaptation in Nusa Tenggara Barat, Indonesia

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ABSTRACT

Effective climate adaptation requires engagement (awareness, motivation, and capacity to act) at relevant scales, from individuals to global institutions. In many parts of the world, research attention has focused on the engagement of the general public. We suggest that studies also need to focus on key stakeholders in the government and non-governmental sectors who participate in adaptation planning processes, so that a better understanding may be achieved of the distinct knowledge cultures that influence their engagement with climate change. Indonesia is a key actor in climate adaptation because of the potentially dire consequences for its population's livelihoods and well-being. In this paper we consider whether 'climate knowledge cultures' exist amongst stakeholders at multiple organisational levels in Nusa Tenggara Barat (NTB) Province, Eastern Indonesia. Surveys were conducted with 124 stakeholders from differing levels at the beginning of four multi-stakeholder climate adaptation workshops. Questions elicited perceptions of their region's challenges, observation and awareness of climate change, feelings they associated with climate change, beliefs regarding causes, risks and preparedness for climate change, and timeframes they associated with the future. Across all levels, climate change ranked highest as the first challenge participants identified, followed by food security, but well-being ranked highest when the top three challenges were combined. Most participants believed climate change was happening, but those working at higher organisational levels were more likely to attribute climate change to human factors whereas those at lower levels were more likely to think it was a natural phenomenon. Women were in greater agreement and more optimistic than men about current government policies to cope with climate change. Perceptions differed between sub-districts, reflecting NTB's climatic diversity. We note that although climate change is an issue of concern among NTB stakeholders, the potential privileging of some knowledge cultures may lead to its association with cultural and political elitism. Second, climate change needs to be viewed alongside the myriad other challenges facing NTB, some of which have greater perceived immediacy. This analysis highlights the need for planning that can accommodate and integrate the diverse knowledge cultures and adaptation objectives that exist at multiple levels.

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Introduction

Climate engagement and knowledge cultures

To be able to adapt to climate change, people – individuals, households, communities, organisations – must be engaged: they must understand what climate change is, feel a motivation to respond to it, and have the capacity to act (Lorenzoni et al., 2007). In practice, the meaning of engagement can be elusive. A substantial body of research has addressed the inter-related cognitive, affective and behavioural dimensions of climate change engagement at the individual level, and has shown that collective human experience with climate change is highly varied (Wolf and Moser, 2011).

For many, climate change is a distant, intractable problem. It is also a contested problem: research in developed countries shows that climate change views of public citizens often (and increasingly) diverge from scientific consensus (Weber and Stern, 2011; Leviston and Walker, 2012) and highlight that the journalistic norms of mass media have wedged apart scientific and popular discourse on the issue (Boykoff, 2011). In the developing world, a contrast is more often drawn between western scientific epistemologies of climate change and local perspectives (Byg and Salick, 2009; Orr et al., 2012). Yet none of these discourses is homogenous, with divergence of views evident among sub-groups of society (Moloney et al., 2014).

What people 'know' about climate change is as much a reflection of their beliefs, values, worldviews and objectives as a descriptive account of what climate change is (Weber, 2006) and what they must do about it. Knowledge of climate change exists in a knowledge-belief-practice complex (Berkes, 1999); that is, knowledge is related to what one believes and what one does. Because climate change cannot always be directly or immediately sensed, individuals are especially reliant on social and cultural cues to inform them about climate change, the risks it poses, and how to respond. Accordingly, several strands of scientific research have focused on social and cultural influences on climate engagement. Kahan et al. (2011) explain climate beliefs through the lens of cultural cognition, whereby individuals adopt views aligned with those of one's cultural community. Leviston et al. (2013) explore cognitive biases in individuals' own beliefs about climate change as well as their opinions of what others believe. Moloney et al. (2014) investigate social representations of climate change, arguing that beliefs and behaviour coexist as part of the system of meaning – the tacit frameworks – used to understand climate change. In their study of Kenyan fishers, Crona and Bodin (2006) consider the role of social networks in shaping ecological and climate knowledge, and whether "what you know is who you know".

This paper is based on the premise that social and cultural influences on knowledge are significantly pervasive to give rise to distinct "knowledge cultures" (Brown, 2008). Knowledge cultures characterise different groups – whether individuals, communities, specialists, organisations or creative thinkers – who use different languages to describe climate change, choose different avenues of action, and are directed towards different outcomes. Notably, Brown asserts, these produce "patterns of difference that are. . .not primarily matters of right and wrong" but "different interpretations of the same reality, each internally consistent and valid within their own terms" (2008, p. 5).

But whose knowledge cultures matter where climate change is concerned? The focus of research on climate engagement on the individual is largely warranted (Rickard et al., 2014): individuals have adapted to climate variability for millennia, and to varying degrees they will be required to adapt to future climate variability and change regardless of institutional frameworks in place that support (or constrain) adaptation. Yet climate adaptation happens on both autonomous individual and planned—often institutional—levels (IPCC, 2007). Furthermore, much of the literature argues that significant barriers to engaging with climate change persist at both individual and societal levels (Lorenzoni et al., 2007; Waters et al., 2014). Thus, research on climate engagement among the general public (e.g. Nisbet and Myers, 2007) needs to be supplemented with studies that focus on individuals who are linked to broader climate adaptation decision-making and planning processes. While research has addressed how to better engage government stakeholders on the issue of climate change through participatory processes (e.g. Shaw et al., 2009), little research has addressed government or other organisational stakeholders' perceptions of climate change, and the distinct understandings and objectives of different subgroups of society in dealing with climate change (but see Moloney et al., 2014).

In this paper we strive to fill a gap by examining understandings of Indonesian stakeholders who are potential 'change agents' for addressing climate adaptation as individuals working within organisations (Visser and Crane, 2010). We anticipate that different knowledge cultures are present within groups of organisational stakeholders with varying levels of exposure to and engagement with climate information in their professional roles and varying local knowledge about climate change. We argue that thinking about engagement with climate change through the lens of knowledge cultures can help inform the design of multi-scale climate adaptation planning processes.

Engagement with climate change in Indonesia

Indonesia is a key actor in climate adaptation given its contribution to CO_2 emissions, but also because of the potentially dire consequences for human livelihoods and well-being due to the island archipelagic nature of the country (Butler et al., 2014). Climate change in Indonesia is anticipated to manifest primarily as changing weather patterns for some regions and higher air and sea surface temperatures (Indonesia Ministry of Environment, 2010), driving increasing extreme weather events and sea level rise. The country has experienced numerous earthquakes, tsunamis and volcanic eruptions throughout its history, and while not climate-related, these events have nonetheless heightened Indonesian experience of environmental

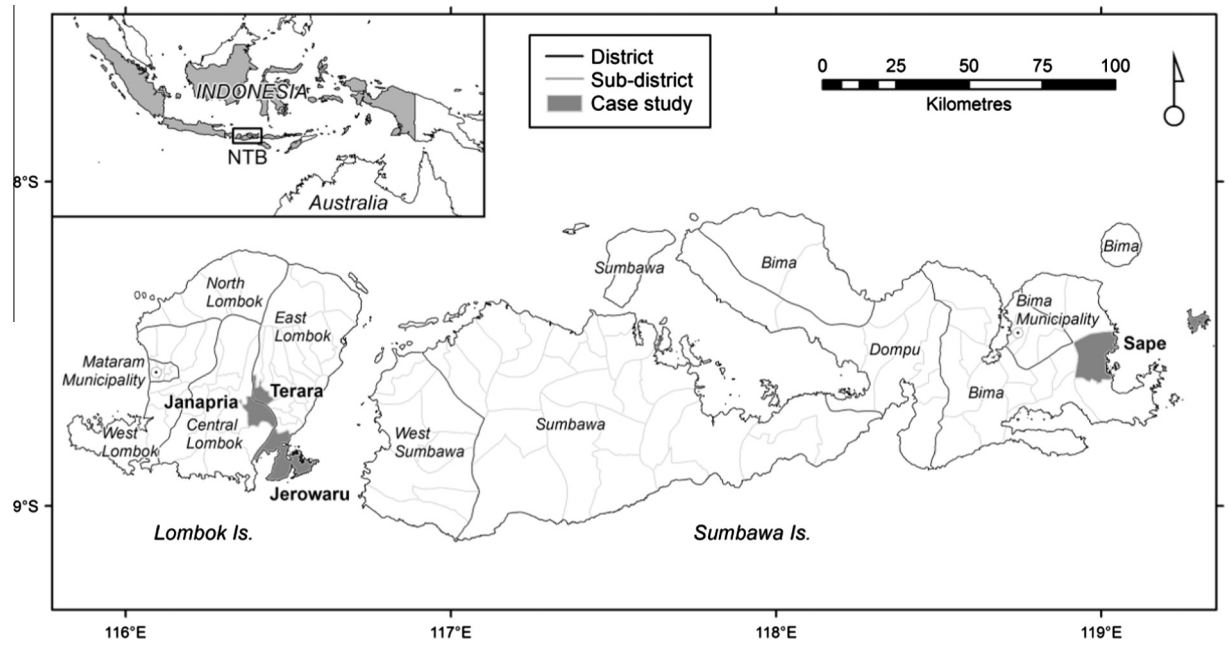

Fig. 1. Location of Nusa Tenggara Barat Province (NTB), Eastern Indonesia, showing the four rural sub-district case studies.

extremes. In 2014 the USA's Secretary of State John Kerry, speaking in the Indonesian capital of Jakarta, likened climate change to "the world's most fearsome weapon of mass destruction" (Gordon and Davenport, 2014). Indonesia, Kerry stressed, "is on the front lines of climate change," a problem that demands that nations and individuals alike become part of a global solution (Yoon, 2014).

However, little of the current scientific theory on climate change engagement seems to have infiltrated Indonesia's climate policy discourse. Recent studies show a high level of awareness of climate change among the Indonesian public (e.g. Orr et al., 2012; Bohensky et al., 2013), possibly buoyed by Indonesia's hosting of the COP in Bali in 2007 and associated local media coverage (Cronin and Santoso, 2010). Yet research in two Indonesian regions showed that household awareness of climate change was largely decoupled from taking action, suggesting that for many Indonesian households, climate change may appear to be less urgent than other problems, or that households may feel absolved of addressing it (Bohensky et al., 2013). Consequently, greater effort needs to be invested in supporting dialogue about climate adaptation with multiple levels of stakeholders.

Our objectives in this paper are to further understanding of multi-level climate adaptation in Indonesia by:

(1) analysing the views of representatives of organisations with responsibility for climate adaptation;
(2) considering whether "climate knowledge cultures" exist amongst these stakeholders, and whether these can be defined by stakeholders' individual and organisational characteristics;
(3) identifying implications for the design of adaptation planning processes.

We explore this in Nusa Tenggara Barat (NTB) Province, one of Indonesia's poorest regions and highly vulnerable to climate change due to the dependence on rural, ecosystem-based livelihoods. Situated in the island archipelago of Eastern Indonesia, NTB consists of two principal islands, Lombok (4725 km^2) and Sumbawa (15,448 km^2) (Fig. 1). An analysis of historical and future seasonal rainfall variability in these two islands shows a decline in the magnitude of wet season rainfall, with potentially serious implications for agriculture and hence food security (Kirono et al., 2016). The province has also been one of the most proactive on the issue of climate change, forming a Climate Change Task Force in 2010 – the first province in Indonesia to do so – with a mandate to integrate climate mitigation and adaptation into development planning (Butler et al., 2016b).

Methods

Framework and data collection

Our theoretical framework for exploring knowledge cultures is loosely organised around Lorenzoni et al. (2007)'s framework of cognition, affect, and behaviour, together with Brown (2008)'s definition of a knowledge culture. To be able to assess our findings relative to other research, we adapted questions asked in previous or ongoing research (Appendix A).

Our instrument for data collection was a survey which elicited NTB stakeholders' views before a series of adaptation planning workshops. A three-stage structured learning process had been developed which involved successive workshops to investigate alternative development pathways for communities from the perspectives of different stakeholders (Butler et al., 2015), which is the subject of this special issue (Butler et al., 2016a). The approach diverges from other community-based adaptation planning processes by first undertaking a provincial analysis of community vulnerability and adaptation in a Stage 1 workshop, followed by case studies of sub-districts in Stage 2 workshops. Stage 3 workshops then integrate stakeholders' perspectives to develop adaptation strategies for each case study sub-district (see Wise et al., 2016). The approach also employs a systems-based analysis that examines multiple drivers of change influencing communities, of which climate variability and change is only one (Butler et al., 2016c).

The survey was designed to understand workshop participants' perceptions immediately prior to the Stage 2 workshops, on the assumption that their views had not yet been influenced by the learning process. None of the Stage 2 workshop participants had attended prior Stage 1 or Stage 2 workshops. The surveys were developed in English and translated into Bahasa Indonesia, and responses were given in Bahasa Indonesia and translated to English for analysis. Nine questions were formulated to assess participants' perceptions of: (1) the community's three greatest challenges in the sub-district, (2) the meaning of climate change, (3) the causes of climate change, (4) feelings they associated with climate change, (5) personal observations of climate change, (6) ways in which they first became aware of climate change, (7) personal risk posed by climate change, (8) their region's preparedness to cope with climate change, and (9) timescales they associated with the future.

The survey instrument was tested at the Stage 1 provincial workshop in May 2011 to ensure the survey questions were understandable and that the instrument was feasible in the given context. This workshop identified four rural case study sub-districts for the Stage 2 process: Sape in Sumbawa Island and Jerowaru, Janapria and Terara in Lombok Island (Fig. 1). The Stage 1 provincial level workshop explored the relative impacts of future change on human well-being in different types of sub-districts (Skewes et al., 2016). This was overlaid with estimates of community adaptive capacity to generate relative vulnerability (Butler et al., 2016c). Case study sub-districts were selected to represent different levels of vulnerability and a range of sub-district types. The Stage 2 workshops were undertaken between October 2011 and January 2012, with a total of 124 participants surveyed (Sape $n = 34$; Jerowaru $n = 32$; Janapria $n = 30$; Terara $n = 28$).

Participants for each workshop were selected through a stakeholder analysis based on their individual or organisational responsibility for and knowledge of community development and natural resource management in the sub-district (see Butler et al., 2015, 2016c). Many held a position where climate adaptation had a specified or at least implied role in their mandate. Thus they were considered potential 'change agents' for addressing climate adaptation in development planning (Butler et al., 2016b). We define these change agents as those who try to effect change from within their organisation (Hartley et al., 1997). Participants included primarily district government staff and local community leaders, plus members of sub-district government and non-governmental organisations (NGOs), and a small number of provincial and national government representatives. Participants were categorised into organisational levels ranging from the lowest (village) to highest (international, including NGOs; Table 1).

The survey was distributed to workshop participants at the beginning of each Stage 2 workshop, who were given approximately 15 min to answer the nine questions. Participants' anonymity was preserved, but numeric identifiers were used so that pre- and post-workshop surveys could later be compared to evaluate individual and social learning.

Analysis

Challenges

Our objective for this question was to understand participants' perceptions of the full range of challenges currently facing communities, and then to understand the relevance of climate change on this spectrum. Stakeholders were asked to identify what they perceived to be the three greatest challenges facing the sub-district. This question was placed first in the survey so

Table 1
Attributes of sub-district workshop participants.

Attribute		Number of participants
Sub-district	Terara	28
	Janapria	30
	Jerowaru	32
	Sape	34
Level	Village	33
	Sub-district	16
	District	46
	Province	2
	National	5
	NGO or international	12
	No answer	10
Gender	Male	83
	Female	22
	No answer	19

as not to skew participants' responses towards climate-oriented issues, which were the primary focus of most subsequent questions. Responses were coded into 14 categories (Appendix B).

First words

To better understand the meaning of climate change to stakeholders, we asked an open-ended question: 'please list the first words that come to mind when you think about "climate change" (please list as many as you would like).' For analysis, the responses were broken into separate words. Generic words such as 'a', 'the' and 'will' as well as 'climate' and 'change' were excluded. Closely related words (e.g. singular and plural) were combined.

Statistical relationships

For the remaining seven questions, statistical analyses were completed to explore: (a) associations between survey responses and participant attributes; (b) associations among survey responses; and (c) clustering of survey responses. The clustering of challenges was also analysed statistically. Interpretation of associations was aided with mosaic plots (not presented here). Analyses were performed with the R software package (R Core Team, 2015).

Relationships between survey responses and participant attributes were examined with contingency table analysis. The degree of association was measured with Cramer's V (ϕ_c). Significance was tested with Fisher's exact test (nominal response and attribute), ordinal logistic regression (ordinal response), logistic regression (binary response and ordinal attribute) and multinomial regression (nominal response and ordinal attribute). For logistic and multinomial regression, administration level (ordinal) was represented as a quantitative variable (category number). For all regression methods, p values were obtained from ANOVA of the model and the null model. Ordinal logistic regression was performed with the R MASS package. Multinomial regression was performed with the R nnet package.

Associations among responses were measured with Cramer's V (ϕ_c). Significance was tested with Fisher's exact test. To examine the more general way in which responses were associated with one another, participants were clustered by their responses. The clustering method was partitioning around medoids, which is a non-hierarchical method similar to k-means. The distance metric was Gower's distance, which accepts the mixed data types of the survey responses. The number of clusters (two) was chosen with the help of silhouette plots.

Relationships between challenges and both participant attributes and survey responses were examined with multivariate regression analysis. We used regression rather than contingency tables because each participant could record multiple challenges for each of three ranks. The data were converted to a participant-by-challenge matrix of scores (1, 2, 3 for ranks 3, 2, 1; 0 for not included). To focus on interpretable relationships, ordinal explanatory variables were represented as quantitative variables (category numbers). Model significance was tested with the Pillai–Bartlett statistic.

Because this was a descriptive analysis of numerous responses and attributes, multiple related significance tests were often performed in parallel, increasing the likelihood that some significant results were due to chance alone. To account for this, we applied the Benjamini–Hochberg multiple testing procedure (Benjamini and Hockberg, 1995) with a false detection rate of 5%. That is, 5% of the null hypotheses that we labelled as having been rejected by this procedure are expected to have been falsely rejected.

Results

Challenges

Fourteen categories of challenges emerged from the coding of responses to the question asking participants to identify the top three challenges (Appendix B). Climate issues (a category which included weather patterns, climate variability, climate change, flood and drought, and sea level rise) ranked highest (24 responses) as the first challenge participants identified, followed by food security (19 responses), but well-being ranked highest when the first, second and third challenges were combined (50 responses; Fig. 2). No answer was given for either the first, second or third challenge by 49 participants. Taking account of these non-answers, climate issues were the third most frequent response overall (46 responses).

First words

Table 2 shows the top three words for each sub-district in response to the question 'please list the first words that come to mind when you think about "climate change". There was much variance between sub-districts in the most frequently-appearing words; the words 'diseases', 'food', 'planting' and 'pattern' were mentioned only by Janapria. By contrast, the words 'hot' and 'drought' were common to all sub-districts but Terara, and the word 'weather' to all sub-districts but Sape.

Results of statistical analysis

Figs. 3–9 present the breakdown of responses for the seven questions that were statistically analysed. Overall, most participants (94%) believed climate change was happening, and 74% believed that climate change has mainly human causes (Fig. 3). Nearly half (48%) felt disturbed (*terganggu*) by climate change (Fig. 4). Climate change had been observed by 88% of

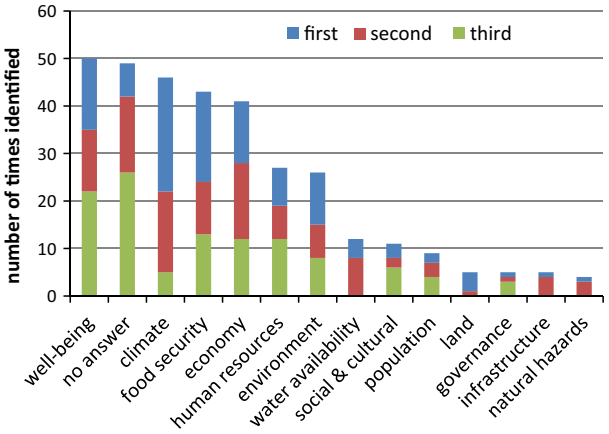

Fig. 2. Issues identified as first, second or third greatest challenges facing communities in the four sub-districts. Issues were categorised according to the coding scheme in Appendix B.

Table 2
Three most frequent words for each sub-district in response to the question "Please list the first words that come to mind when you think about "climate change" (please list as many as you would like)." The words 'climate' and 'change' are excluded. Words unique to a sub-district are shown in bold, and words common to three sub-districts are italicised.

Janapria		Jerowaru		Sape		Terara	
Word	Occurrences	Word	Occurrences	Word	Occurrences	Word	Occurrences
Diseases; *hot*	6	*Hot*; *weather*	9	*Hot*	9	Irregular	8
Food; season	4	*Drought*; irregular; temperature	6	Season	8	*Weather*	5
Drought; **pattern**; **planting**; temperature, *weather*	3	Flood	5	*Drought*	7	Flood	4

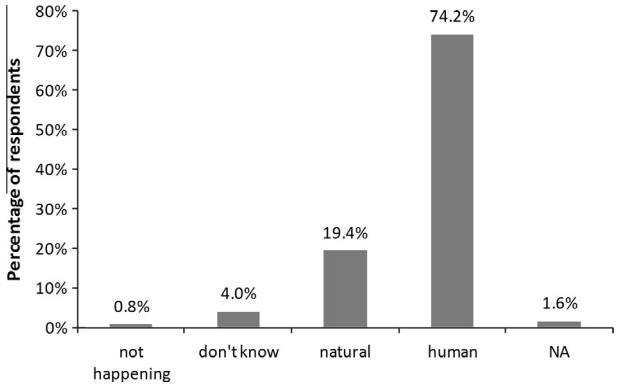

Fig. 3. Causes of climate change. Percentages of responses to the question "which of these statements do you most agree with? (please circle one): I don't think climate change is happening; I have no idea whether climate change is happening or not; I think that climate change is happening but it's just a natural fluctuation in Earth's temperatures; I think that climate change is happening and I think that humans are largely causing it." NA = no answer.

participants in their lifetimes (Fig. 5), and 42% first became aware of climate change through personal observation (Fig. 6). Many (66%) agreed or strongly agreed that climate change posed a personal risk (Fig. 7), and 69% agreed or strongly agreed that government policies are enabling the sub-district to cope with climate change (Fig. 8). Nearly two-thirds (62%) of participants thought of the future as more than 20 years (Fig. 9).

Associations between survey responses and participant attributes

Six relationships between survey responses and participant attributes were accepted as significant by the multiple testing procedure (Table 3). Belief was correlated with level, where more participants from higher organisational levels thought climate change was caused by humans whereas those in lower levels were more likely to think climate change was a natural

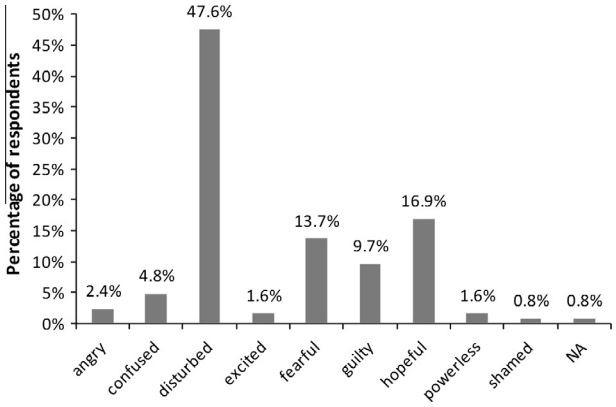

Fig. 4. Feelings associated with climate change. Percentages of responses to the question "what does climate change cause you to feel?" NA = no answer.

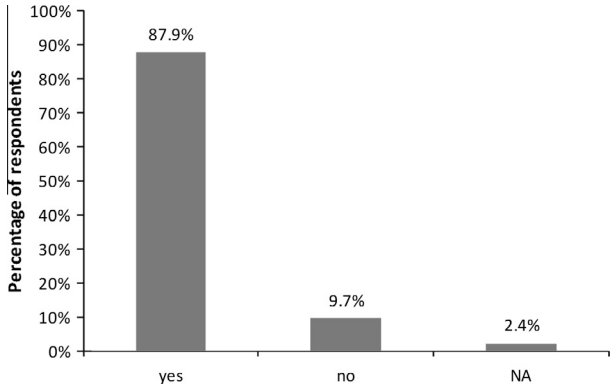

Fig. 5. Observation of climate change. Percentages of responses to the question "have you observed climate change in your lifetime?"

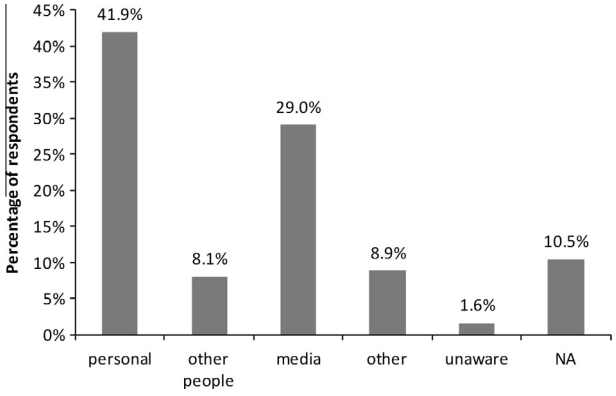

Fig. 6. Awareness of climate change. Percentages of responses to the question "how did you first become aware of climate change? I personally observed it; I learned about it from other people; I learned about it from the media; other; I am not aware of climate change." NA = no answer.

phenomenon. Participants in lower levels were more likely to have first become aware of climate change through personal observation. Participants in higher organisational levels were more likely to agree that they were at personal risk from climate change. Participants in higher levels thought of the future as greater than 20 years, whereas participants at lower levels tended to think of the future on shorter time frames. Participants in higher levels had more negative feelings about climate change. Feelings about climate change varied among subdistricts, with participants from Jerowaru reporting the highest frequency of negative feelings.

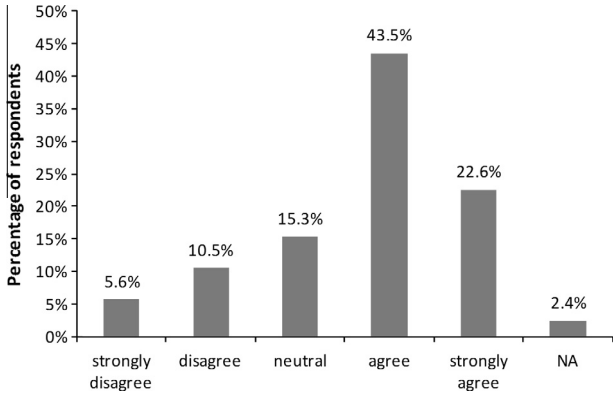

Fig. 7. Personal risk posed by climate change. Percentages of responses to the question "how much do you agree with the following statement?: "climate change poses a risk to me personally." NA = no answer.

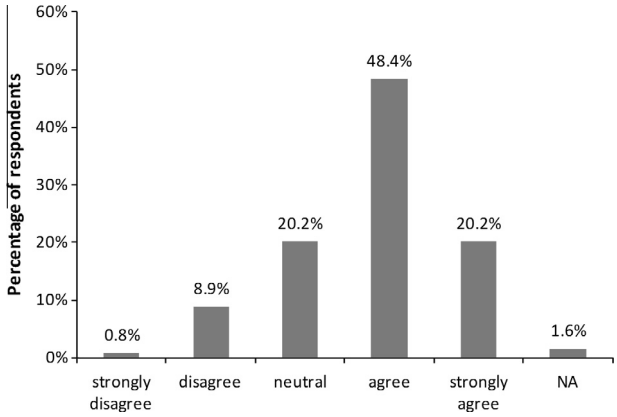

Fig. 8. Region's preparedness to cope with climate change. Percentages of responses to the question "how much do you agree with the following statement?: "the government's policies are enabling the sub-district to be ready to cope with climate change."

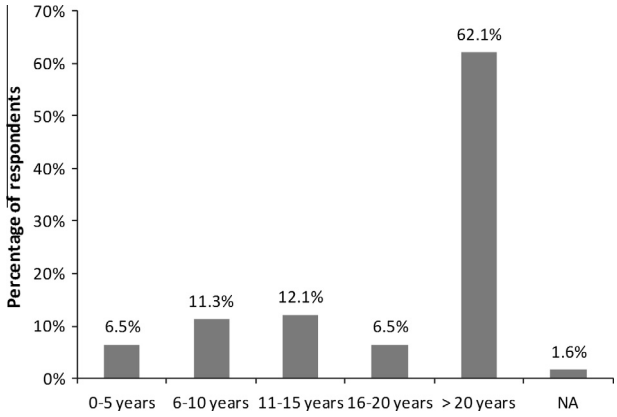

Fig. 9. Timescales associated with future. Percentages of responses to the question "how many years into the future do you think about when you hear the word 'future'?"

Associations among survey responses

Climate change beliefs and mode of awareness were significantly associated (Table 4). Those who believed climate change is natural were more likely to have first become aware of climate change through personal observation than by other means. Those who believed it is human-induced were also most likely to have first become aware through personal observation, but this was closely followed by awareness from media, then to a lesser extent awareness from other people.

Table 3
Responses by participant attributes. Association strength is indicated by Cramer's V (ϕ_c). Significance tests varied according to response type as described in the text. Asterisks indicate significance according to the Benjamini–Hochberg multiple testing procedure. Less than 5% of the asterisked tests are expected to be false positives. The attribute 'sector' was not tested due to insufficient counts in some cells. Responses to the 'feelings about climate change' question were recoded into two categories (positive and negative feelings).

Attribute	Climate change belief		Observed climate change		How first aware of climate change		Personal risk posed by climate change		Ability of policies to cope with climate change		Years equated with future		Feelings about climate change (recoded)	
	ϕ_c	p	ϕ_c	P	ϕ_c	p	ϕ_c	P	ϕ_c	p	ϕ_c	P	ϕ_c	p
Sub-district	0.22	0.07	0.22	0.06	0.18	0.77	0.22	0.69	0.22	0.02	0.20	0.81	0.33	0.0008*
Level	0.31	0.01*	0.14	0.40	0.25	0.002*	0.22	0.013*	0.24	0.85	0.24	0.00009*	0.40	0.00002*
Gender	0.19	0.20	0.15	0.20	0.22	0.40	0.19	0.73	0.32	0.29	0.20	0.32	0.15	0.14

Table 4
Associations among responses. Association strength is indicated by Cramer's V (ϕ_c). Significance was tested with Fisher's exact test. Asterisks indicate significance according to the Benjamini–Hochberg multiple testing procedure. Less than 5% of the asterisked tests are expected to be false positives.

Survey responses	Observed		How first aware		Personal risk		Ability of policy to cope		Years equated with future		Feelings about climate change (recoded)	
	ϕ_c	P	ϕ_c	P	ϕ_c	p	ϕ_c	p	ϕ_c	P	ϕ_c	p
Belief	0.07	0.56	0.32	0.008*	0.28	0.007*	0.22	0.03	0.24	0.054	0.47	0.000006*
Observed			0.32	0.005*	0.20	0.45	0.11	0.54	0.08	0.80	0.08	0.69
How first aware					0.16	0.82	0.29	0.69	0.29	0.002*	0.29	0.03
Personal risk							0.26	0.02	0.21	0.16	0.20	0.18
Ability of policies to cope									0.25	0.014*	0.26	0.054
Years equated with future											0.22	0.20

A significant association was also found between climate change beliefs and risk perception. Those who believed climate change is natural were less likely to perceive personal risk from climate change; they agreed or were neutral (in about equal numbers) in regards to the statement that climate change poses a personal risk, while those who believed climate change is human-induced were more likely to agree, and to a lesser extent strongly agree, that it poses personal risks. Participants who believed climate change was human induced were more likely to express negative feelings about climate change.

Additionally there were other notable associations. Those who believed climate change is human-induced were less likely than other participants to have observed it personally. Those who first became aware of climate change from the media were more likely to think about the future in longer terms than those who observed it personally. Those who agreed that their subdistrict's policies could cope with climate change were more likely to think of the future in longer terms.

Cluster analysis of survey responses

A cluster analysis of the survey responses (described above) defined two clusters of participants. Cluster one was characterised by participants who believed that climate change is human-induced, first became aware of climate change from the media or other sources, were less likely to have personally observed climate change, personally perceived themselves to be at risk, perceived the future in longer terms, and felt disturbed, fearful or guilty. These participants tended to be in higher organisational levels.

Cluster two was characterised by participants who believed that climate change was natural, had observed climate change personally, first became aware of climate change by personally observing it, had no strong view about whether they were at risk, perceived the future in more immediate terms, and felt hopeful, disturbed or fearful. These participants were predominately from lower organisational levels.

Associations between challenges and attributes

Significant relationships were found between challenges and sub-district, where Jerowaru participants were most likely to identify climate issues as one of the greatest challenges (multivariate regression $p < 0.001$; significant under multiple testing). R^2 values for the significant component regressions were 0.09 (climate), 0.07 (economy) and 0.05 (wellbeing). For all other attributes and responses, the overall multiple regression tests were not significant (with or without multiple testing). In general, although participants varied in the challenges they nominated (Fig. 2), these challenges were not strongly predicted by participant attributes or related to responses to other questions.

Discussion

The interpretation of these findings in light of the broader body of research on climate change engagement suggests that some, but not all, aspects of the NTB climate knowledge cultures we encountered have currency across the globe. We first discuss this, and then turn to some implications and complexities of these varied knowledge cultures.

Historical climate analysis for NTB shows negative trends in rainfall over the past 50 years (Kirono et al., 2016), which is consistent with the association of climate change with the word 'drought' in the workshop surveys. That 88% of workshop participants had observed climate change in their lifetimes, and that 66% stated that it posed personal risk also resonates with research findings elsewhere in Indonesia, obtained from both large household surveys (Bohensky et al., 2013) and studies with smaller numbers of government representatives (CSIRO, 2012; Larson et al., 2012) and communities (Orr et al., 2012). In this study, one of the first words associated with climate change was 'hot' for three of the four sub-districts; this was also the first word associated with climate change among government, scientist and community respondents in Moloney et al. (2014)'s Australian study.

A slightly greater percentage of NTB workshop participants thought that climate change was happening (94%) than in Leviston et al. (2014)'s Australian survey (86%); more strikingly, more NTB participants agreed that climate change had mainly human causes (74%) compared to Leviston et al. (2014)'s study in Australia (47%). This is consistent with findings from a study in the Indonesian city of Makassar, where a survey undertaken amongst 34 government and university stakeholders found that 86% perceived that climate change has human causes (CSIRO, 2012; Larson et al., 2012). NTB participants ranked climate change high relative to other challenges, contrasting with Leviston et al. (2014)'s findings in Australia.

Observation of climate change was also much more prevalent among NTB participants than in a US study, where only 27% of adults surveyed in one county felt that they had personally experienced global warming (Akerlof et al., 2013). This is in stark contrast to the more than 80% of NTB participants who stated that they had personally observed climate change, and in another Indonesian study (Bohensky et al., 2013). Vigorous debate has attended the question of whether experience of climate change impacts, such as extreme weather events, leads to proactive engagement with climate change (Weber, 2006; Dessai and Sims, 2010; Whitmarsh, 2008; Spence et al., 2011; Wolf and Moser, 2011; Akerlof et al., 2013). How individuals and society encode experience and whether they associate this experience with climate change may be key (Bohensky and Leitch, 2014). In developed countries, climate change perceptions have been seen to reflect 'interpretive communities' sharing similar (socially constructed) risk perceptions, worldviews and social and demographic characteristics (Leiserowitz, 2005). Views about climate change may also split along lines of political division (Kahan, 2012).

The cluster analysis of our data implies that direct experience, the perception that climate change has anthropogenic causes, and the perception of risk are not necessarily linked, and indeed other factors may be at play. Interpretation of one's experience of climate impacts is often fundamentally linked to perceived options and agency for addressing climate change (O'Brien et al., 2009; Adger et al., 2013). Interestingly, in our study, those believing climate change to have human causes, and perceiving personal risk, were more convinced that existing policies were able to cope with climate change, although we did not ask participants to specify which policies or levels of implementation they were considering.

Of the associations investigated statistically, the organisational level and gender of participants had the greatest influence on perceptions, albeit in different ways: level was related to beliefs about causes (higher levels believed in human causes), while gender was related to beliefs about the ability to respond (women were in greater agreement and more optimistic). Gender differences with respect to climate engagement have been noted elsewhere. Amongst the Australian public, for example, Leviston et al. (2014) found a small association between gender and the belief that climate change is happening (women being more likely to believe). Wolf and Moser (2011) found that women express slightly greater concern about climate change.

The results also indicate geographical differences in views of climate change and greatest challenges for the subdistricts. Notably, Janapria participants associated unique words with climate change (diseases, food and planting patterns) despite being located adjacently to Terara and sharing the same typology of primary resource use (rice and tobacco; Rochester et al., 2016). These results further demonstrate the steep cultural, livelihood and agro-ecosystem gradients typical of NTB (Butler et al., 2014), and the localised variability in historical and potential future climate change (Kirono et al., 2016; McGregor et al., 2016). The results also indicate that knowledge cultures may be defined along occupational lines, given that a higher likelihood of participants from NGOs or international organisations named climate change as one of the greatest challenges.

In addition, we observed variance in temporal definitions of the future. Perspectives on time have received little attention in climate adaptation research, which, critically, may diverge between different stakeholders and may not align with adaptation policy (Barnett, 2014; Fincher et al., 2014). Tonn et al. (2006) found in a multi-national survey that most individuals perceive the future as a point in time about 10–15 years from the present. This differs somewhat from our findings for NTB, where 62% of respondents thought of the future as more than 20 years, and were more likely to do so if they were working at higher organisational levels. Tonn and MacGregor (2009) found that most people engage with their future proactively, drawing on multiple approaches to consider the future, including "relying on personal past experiences, imagining future situations, and relying on their personal intuitions" (p. 1). Importantly, they found that most respondents do not pattern their future decision making on decisions made by others, or on tradition, which stands in contrast to the literature emphasising social and cultural influences. Tonn et al. (2006) also explored the role of religious affiliation in thinking about the future,

hypothesising that those believing in theological determinism would be less concerned about the future. Indeed, their survey showed that Christians were more optimistic and less worried about the future than non-religious respondents. They also found that those affiliated with traditional Asian faiths, including Islam (e.g. the majority of Indonesians), were more likely to plan for the short-term *and* long-term future. On the other hand, the prevalence of passive and fatalistic worldviews in Indonesia (Butler et al., 2014) might suggest a disengagement with the future, but this was not borne out in our study.

"Disturbed" was the emotion that participants associated most with climate change, followed by "hopeful" and then "fearful." However, differences in emotions manifested in the two clusters, where participants in the cluster that was more likely to believe that climate change has human causes tended to feel disturbed, fearful or guilty, and the cluster that was more likely to believe that climate change has natural causes tended to feel hopeful, disturbed or fearful. For Australian survey respondents who were asked if they experienced a similar set of emotions, the most frequent answer was "irritated" or "angry", followed by "powerless" and then "hopeful" (Leviston et al., 2014). In NTB, neither "angry" nor "powerless" was a common response, perhaps suggesting a more passive attitude towards climate change or a greater level of acceptance. This correlates with other studies in Indonesia that found a generally passive worldview underpinning poverty (Dofford, 2011), also evident amongst rural communities in NTB (Suharto et al., 2003; Jakimow, 2014).

What are the implications of these diverse, complex knowledge cultures for action on climate change in NTB? A strong signal in our data is that knowledge cultures in line with the global scientific consensus on climate change are more prevalent amongst those at higher administrative levels and are not strongly rooted in personal observation of climate change (and while not examined here, this may co-vary with other attributes, such as levels of education, income, and geography). An important corollary seems to be that while stakeholders were invited to participate in the project on the basis of their actual or potential role as a change agent, it is evident not only that these individuals have differing knowledge cultures, but are also likely to have varying levels of influence and power. As noted elsewhere, some individuals are more effective change agents than others (Visser and Crane, 2010), and indeed, some processes of knowledge exchange in which different knowledge cultures contribute, are more effective than others (Fazey et al., 2014). Clearly the diversity of worldviews and knowledge cultures about climate change among the stakeholders in this project suggests that multi-level stakeholder engagement and partnerships that acknowledge this diversity and power asymmetries are needed (Blake, 1999; Leiserowitz, 2005; Brown, 2008).

Although we did not investigate the relationships between views about climate change and adaptation actions taken by the participants in this study, multiple strands of theory – in addition to those discussed above – shed light on these relationships. Literature on corporate sustainability reveals influences on managers' motivations that our research does not address, such as instrumental incentives (i.e. career and salary prospects) and normative aspirations (i.e. altruism) (Visser and Crane, 2010). Organisational studies research suggests that identity and status within an organisation and professional field are key; among professionals working in a Canadian petroleum industry, Lefsrud and Meyer (2012) found that individuals' embeddedness within their organisations exerts a strong influence on their ability to affect decision-making. While those aligning themselves with a knowledge culture that accepts the global consensus on climate change would tend to support the need for action, this does not necessarily translate into action at personal or professional levels (Blake, 1999). Yet because most of the existing literature deals with the general public rather than professionals and change agents, we are cautious about extrapolating.

Two other points deserve mention. First, the spatial scale of knowledge is a defining dimension of a knowledge culture. Western scientific epistemologies on climate change have formed a dominant, though partial, knowledge culture that tends to overshadow critical local perspectives, which in themselves are diverse (Byg and Salick, 2009). Yet Roth (2004)'s research shows that a better understanding of the spatial expression of knowledge operating at distinct scales can help lead to a more fruitful integration of knowledge and practice produced at different scales. Again, this underscores the need for coordinated cross-scale planning to ensure that responses to climate change, and other drivers, at these different levels are not counterproductive and therefore maladaptive, which can result when planned and autonomous adaptation are simultaneously occurring (Bohensky et al., 2013; Butler et al., 2014).

Lastly, knowledge cultures around climate change are likely to reflect a process of cultural cognition, whereby individuals maintain views that uphold their cultural commitments (Kahan, 2012). In some developed countries this phenomenon is expressed in the rejection of scientific views in favour of a denialist narrative crafted by a conservative elite (Weber and Stern, 2011). In Indonesia, elitism is more likely to be associated with acceptance of climate science, stemming from privileged knowledge about climate change risks that may alienate those who are excluded from these knowledge cultures. Therefore, shifting the focus of climate communication and policy from debating causes to collectively understanding localised impacts and formulating adaptation responses could circumvent this potential problem (Brown and Harris, 2013; Barnett et al., 2014), justifying the multi-stakeholder planning approach examined in this special issue (Butler et al., 2016b).

Several caveats associated with this study need to be acknowledged which should be addressed in future research where possible. First, we note that by framing this research and the stakeholder workshops around climate change and adaptation, we may have raised expectations of participants or inadvertently encouraged them to indicate a higher (or lower) demonstration of awareness and concern about climate change in their survey responses. Although participants were anonymous, cognitive processes can lead participants to respond in a way that produces perceived 'identity benefits' from expressing concern (or alternatively, scepticism) about climate change (Bain et al., 2012). Secondly, we undertook this research in a single Indonesian province, and while the resonance of some results with other studies suggests wider applicability, the

potential for duplicating the research process elsewhere is unknown (but see Butler et al., 2015). These indicate significant areas of potential future research.

Conclusion

In this paper we sought to deepen research into climate change engagement through an emphasis on 'climate knowledge cultures' in an Indonesian province, focused on government and other organisational stakeholders to gain insight into the institutional and political contexts for possible climate change responses. We argue that thinking about engagement with climate change through the lens of knowledge cultures can help enrich the design of multi-scale climate adaptation planning processes so that the diversity of views on climate change and their associated values can be more fully appreciated and managed (Stone-Jovicich et al., 2011; CSIRO, 2012) and indeed, can expand the solution space in which collective social learning plays a part (Brown, 2008). Furthermore, the recognition that some aspects of climate knowledge cultures in NTB resonate with those elsewhere in the world can help the province link to partners, processes, ideas and resources for adaptation planning beyond NTB. This analysis also suggests an opportunity for theory development around the roles of knowledge cultures, social representations, social networks and cultural cognition of climate change and adaptation, which may have different levels and modes of influence from that observed in the developed world where perceived direct experience of climate change may be less common.

Climate change is an issue of concern among the NTB stakeholders who participated in this project, though the notion of anthropogenic climate change as a problem that demands a concerted institutional response seems to have more currency at higher administrative levels, potentially creating an association with cultural and political elitism. While climate change is acknowledged in this region as important, it must be seen in the context of other challenges facing NTB, of which many were named. Stakeholders expressed high levels of concern about well-being and food security, issues with multi-faceted links to climate change but perceived to be in the "here and now." However, climate adaptation is an urgent policy activity that needs to begin now to avoid dangerous futures and requires practices that can be sustained over the long term (Barnett, 2014).

Diverse knowledge cultures are important for maintaining flexible livelihoods in transitioning economies such as Indonesia (Lagerqvist, 2014). This analysis highlights the need for planning that accounts for the diverse knowledge cultures that exist at multiple individual, organisational and spatial levels and which can integrate and accommodate these.

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Appendix A

Aspects of climate knowledge culture addressed by survey questions, question wording, type and comparative studies that asked similar questions.

Aspect of climate knowledge culture	Question	Question type	Comparative studies
Perception of drivers of change[1]	What are the greatest challenges facing communities in [*name of sub-district*]? (please list the top 3 in order; from greatest to smallest)	Rank top 3	Milne Bay, PNG (Bohensky et al., 2011)
Perception of climate change	Please list the first words that come to mind when you think about "climate change" (please list as many as you would like)	Freelist	Makassar, Indonesia (Larson et al., unpublished data) Australia (Moloney et al., 2014)[2]
Perception of causes of climate change – natural vs. anthropogenic	Which of these statements do you most agree with? (please circle one): (1) I don't think climate change is happening; (2) I have no idea whether climate change is happening or not; (3) I think that climate change is happening but it's just a natural fluctuation in Earth's temperatures; (4) I think that climate change is happening and I think that humans are largely causing it	Multiple choice	Australia (Leviston et al., 2014)[3]
Affective engagement with climate change	How does climate change make you feel? (please circle one): angry, shamed, guilty, fearful, hopeful, powerless, joyful, confused, excited, bored, disturbed	Multiple choice	Australia (Leviston et al., 2014)[4]
Personal experience with climate change	Have you observed climate change in your lifetime? (please circle one): yes/no	Yes/no	East Kalimantan and Central Java, Indonesia (Bohensky et al., 2013)
Awareness of climate change	How did you *first* become aware of climate change? (please circle one): I personally observed it; I learned about it from other people; I learned about it from the media; other (explain); I am not aware of climate change	Multiple choice	East Kalimantan and Central Java, Indonesia (Bohensky et al., unpublished data)

Appendix A (*continued*)

Aspect of climate knowledge culture	Question	Question type	Comparative studies
Perception of climate change risk	How much do you agree with the following statement?: "climate change poses a risk to me personally"	Five-point Likert scale	East Kalimantan and Central Java, Indonesia (Bohensky et al., 2013)
Perceived coping capacity	How much do you agree with the following statement?: "the sub-district's climate adaptation policies are enabling the sub-district to be ready to cope with climate change"	Five-point Likert scale	Makassar, Indonesia (Larson et al., 2012)[5]
Perception of timescales associated with future	How many years into the future do you think about when you hear the word 'future'? (please circle one): 0–5; 6–10; 11–15; 16–20; >20	Multiple choice	Multiple countries (Tonn et al., 2006; Tonn and MacGregor, 2009)[6]

[1] Bohensky et al. (2011) asked "What do you think is the biggest threat to ecotourism in Milne Bay Province?"
[2] Larson et al. asked "Please list the first words that come to mind when you think about climate change (please list as many as you would like)". Moloney et al. (2014) asked "write down the first words that come to mind when you think about climate change."
[3] Leviston et al. (2014) asked "What best describes your thoughts about climate change? (multiple choice: (1) I don't think climate change is happening; (2) I have no idea whether climate change is happening or not; (3) I think that climate change is happening but it's just a natural fluctuation in Earth's temperatures; (4) I think that climate change is happening and I think that humans are largely causing it)".
[4] Leviston et al. (2014) asked "How does climate change make you feel?" (with a list of responses). We used the same list of responses, except that we substituted "irritated" with "disturbed" which translated into Bahasa Indonesia with less ambivalence, and we omitted "despairing".
[5] Larson et al. (2012) asked "How much do you agree with the following statement?: "Makassar city has climate adaptation policies that will enable it to be ready to cope with climate change."; Tonn et al. (2006) asked "How responsibly is humankind addressing the major issues that will impact the future?"
[6] Tonn et al. (2006) asked "When you hear someone use the word future, approximately how many years into the future does this mean to you?"

Appendix B
Coding scheme for the 'three greatest challenges' question.

Code	Responses included
Climate	Weather patterns, climate variability, climate change, including flood and drought, sea level rise
Economy	Economy – including employment, tourism
Environment	Environment-related issues including degradation from various causes including human activities, extractive industries (mining, deforestation), and pollution (not climate-specified)
Food security	Food security, agriculture, fisheries, land availability for food, famine
Governance	Governance
Human resources	Human resources – including education, behaviour, capacity (e.g. knowledge, awareness, skills)
Infrastructure	Infrastructure and energy, technology, communication (e.g. mobile networks, internet etc.)
Land	Land issues (not agriculture-specified, e.g. ownership)
Natural hazards	Natural hazards (not climate-specified)
Population	Population growth and other population issues
Social and cultural	Social and cultural change
Water availability	Water availability
Well-being	Well-being, including health, income, livelihoods, poverty, security, vulnerability, social networks and relations
No answer	No answer or unclear

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